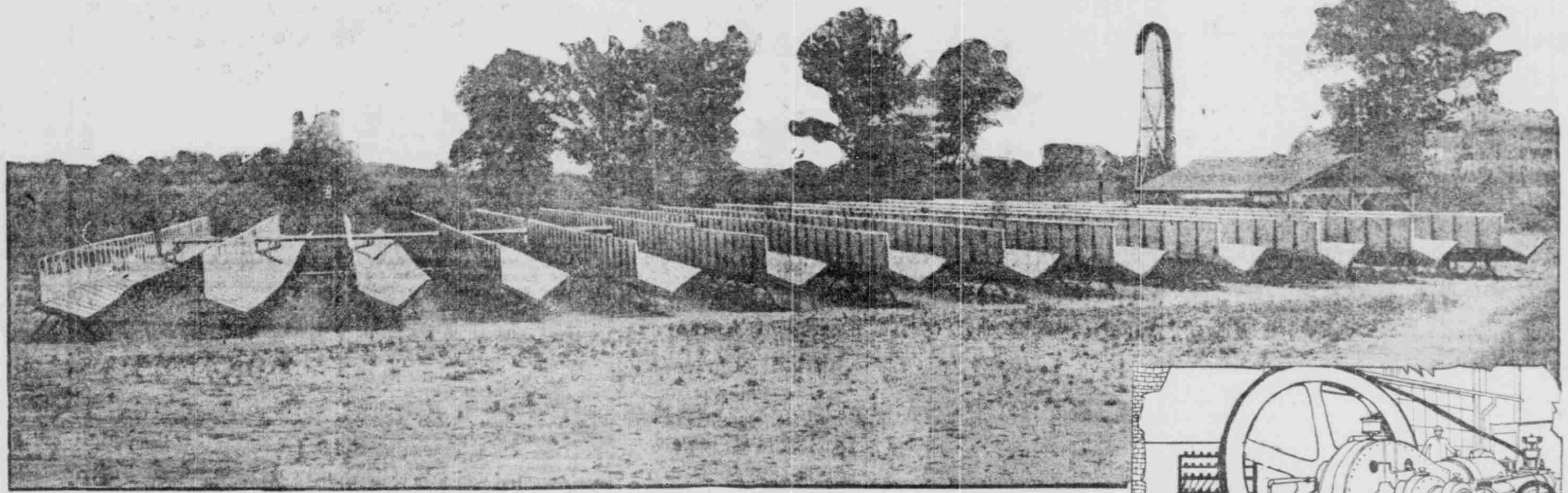
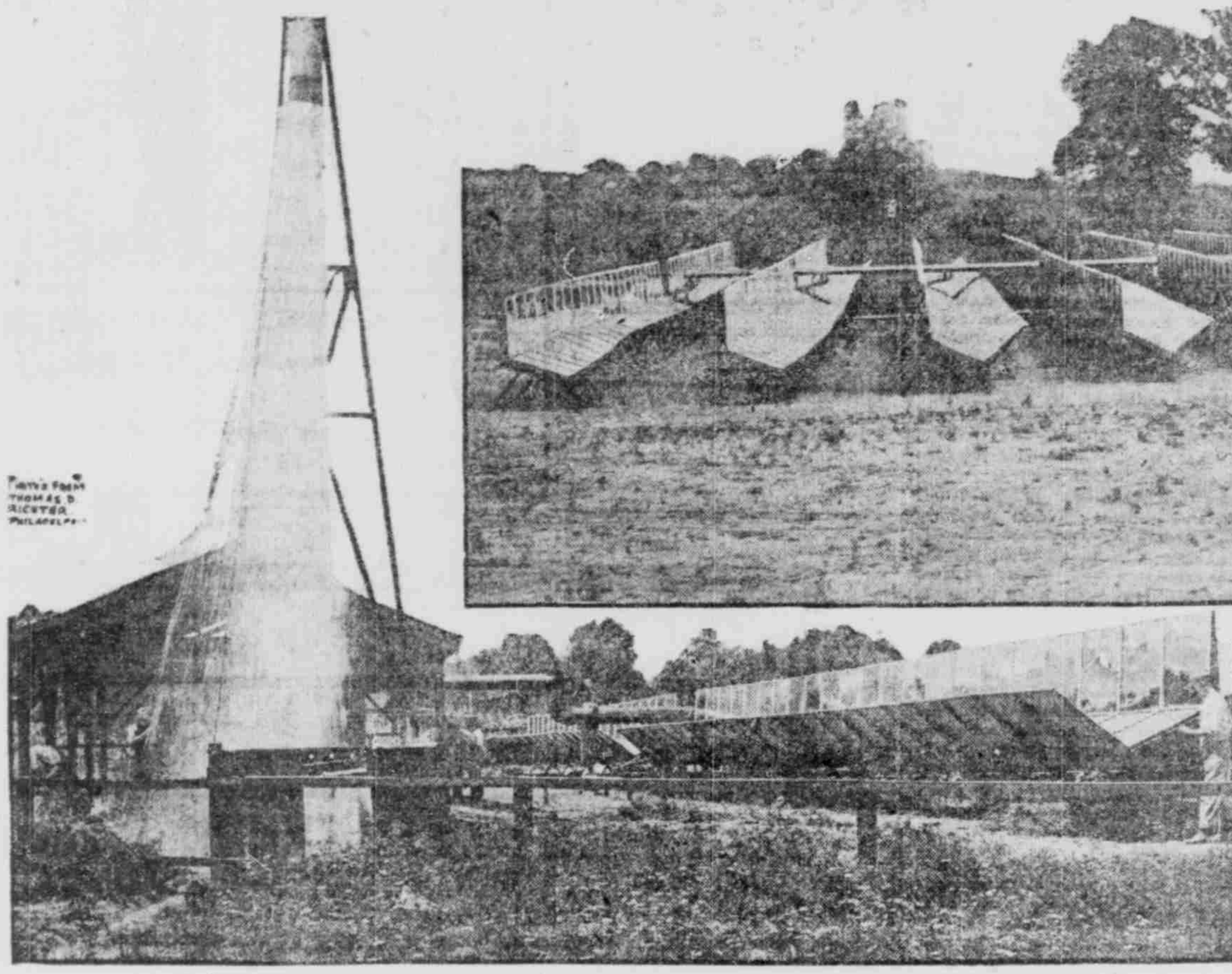
Science's Plan to Store Summer's Heat for Winter's Use.



A Sun Motor Plant in Texas Which Collects the Heat of Our Luminary and Uses It to Drive an Engine and Generate Electricity. Similar Mechanism, It Is Suggested, Could Store the Excess Heat in the Shape of Electricity and Release It in Winter in the Form of Heat.



Water Being Pumped Sixty Feet by th- Sun's Rays.

The Possibilities of "Packing Away" the Sun's Radiation to Help Out Our Dwindling Fuel Supply Discussed by Professor Garrett P. Serviss

By Prof. Garrett P. Serviss.

NEVER has civilized man, proud of his achievements and confident in his continually developing power, received such a savage and unanswerable reminder of his absolute subjection to the vagaries of natural forces as that which came to us like an arrogant slap in the face last Winter. The same catastrophe will happen to us again unless we make provisions against it.

At the great crisis in the world's history, when we needed to use all our powers and capacities at their maximum of efficiency, we found ourselves held in the merciless grip of frost—ships tied up, railroads blocked, factories choked, highways made impassable, rivers and harbors choked, reservoirs frozen, pipes and conduits split by ice, cities buried in snowbanks, communications broken, fleets and armies arrested, industries paralyzed, and a whole nation shivering with cold and threatened with hunger.

We fight the cold by burning wood and coal. But what will we do when the wood and coal are exhausted? The situation that will then confront us is vividly and brutally presented by the terrible dilemma in which the simple arrest of the distribution of coal threw our industries and our home life, to say nothing of our national affairs. If there were no coal whatever to distribute, even an ordinary Winter would suffice to reduce us to a similar condition, and there would be no escape from it at the end of a few weeks as at present. It would be a complete freeze-out every Winter except inside the tropics.

Just as he first burned up practically his whole supply of wood, so now civilized man—the child of tempered Winter—is burning up his whole supply of coal. And when that is gone, he knows not where to go for something to take its place. But he must find or invent that something, or else not only will civilization perish, but three-quarters of the human race will also perish, since the tropics cannot hold them, while untempered Winter in the higher zones would freeze out their energies.

Two lines of solution are suggested; first, the discovery of new forms of fuel, or new methods of producing thermal energy, and, second, the conservation of heat already furnished by nature. Let us take up the last first. To suggest baldly that we might contrive something resembling in its operation, though not in its form, a gigantic thermos bottle, by means of which the solar heat of Summer could be stored up and released where and when wanted in Winter, cannot make much appeal to minds accustomed to deal only with scientific realities, but it must have a charm for the more imaginative type and might be fertile. Suppose, for instance, that we attack the problem in this way: When a gardener wishes to start his plants before the Winter chill has left the air he covers the ground in which they grow with a mantle of glass.

This lets in freely the bright sunshine, which warms the ground, and at the same time prevents the escape of the obscure heat waves from the warmed ground. The result is that he makes a reservoir of heat which has come primarily from the sun, and thus he defeats the season which, but for his ingenuity, would freeze his plants. So, in the Spring he can artificially hasten the coming of solar heat, and in the Autumn he can prolong its stay—over a limited area. Within that area he is master of the situation. Even in mid-Winter a room may be considerably warmed by letting plenty of sunshine enter through large, tight-fitting glass windows and imprisoning its heat there.

Now take another step, guided by facts well known. As the glass of the hothouse imprisons captured thermal rays derived from the sun, so the earth's atmosphere, largely because of the water vapor which it contains, traps solar heat for the whole planet. If there were no air surrounding the earth its surface at night would be unendurably sold, and even by day an icy temperature would prevail in all shadows. The heat, even in full sunshine, would be radiated away so rapidly that it could not penetrate to any depth in the soil. On the other hand, if the heat-capturing power of the atmosphere could be doubled or tripled the terrors of the severest Winter would be warded off.

Experiments show that the power of the atmosphere to trap heat is largely due to the water vapor that it contains. It is also due, to some extent, to the carbon dioxide gas that is one of its minor constituents. Carbon dioxide is a remarkable heat retainer, but there is only a very small quantity of it in the air compared with the vast bulk of the atmosphere. It only amounts to about 3-100ths of 1 per cent. But there is this significant fact about it, viz., that its amount is variable, to a slight degree at the present time, while there is evidence from past geological history that once it was vastly more abundant than it is now.

Now, how much carbon dioxide must the air gain in order that a perceptible effect on the temperature may be produced? Arrhenius answers this question for us. He says that if all the carbon dioxide now in the air were removed the average temperature would fall nearly 38 degrees Fahrenheit. On the other hand, if the present amount were doubled the temperature would rise more than 7 degrees, and if it were quadrupled the rise would amount to nearly 14½ degrees, which would be far more than enough to banish all the glacial suffering that we had to endure last Winter. Even the smaller amount of insrease (7 degrees) would probably surfice for that.

But, granted all this, the question still remains: Is it conceivable that man could successfully interfere with so vast a concern of nature as the composition of the air of the whole world? The answer is: Yes; it is more than conceivable; it is nearly probable. In fact, we have reason to believe that man *has* measurably altered the constitution of the air by varying the relative amounts of some of its constituents. *And what he has done is exactly the thing in question, viz., increasing the amount of carbon dioxide.*

It has been estimated that the burning of coal in recent years has annually furnished to the atmosphere about 0.00166 per cent of the amount of carbon dioxide that it normally contains. Then, in 600 years the percentage of carbon dioxide will be doubled by the agency of man alone, provided that it all remains in the air. Vegetation absorbs a great deal, but gives most of it back again in roundabout ways. The sea absorbs a great deal, but only enough to maintain an equilibrium with the air, so that the latter must retain a certain proportion of its gain.

If human agency now adds carbon dioxide to the air at such a rate that the quantity will be doubled in 600 years, then, if the annual supply were increased sixfold, the doubling would be effected in 100 years, and if sixtyfold, in ten years. So here we have a theoretical means of effecting the needed change of climate; it shows how it could be done, and how nature has evidently done it in the past, but it is a method that works too slowly. We cannot, without a fundamental discovery to aid us, supply carbon dioxide fast enough to effectively aid the present generation, nor the next, nor the next.

To be sure, if we all worked together to pour into the air 600 times as much of this gas as we now do we should, according to the calculations, double the atmospheric percentage and bring about a new climatic situation in a single year. But, even if the coal mines could withstand the drain, it would not be practicable to do the work. If we could find some other source of carbon dioxide than coal, then it might become another question. We know of one such source, of gigantic capabilities, viz., gaseous emanations from the interior of the earth, particularly from volcanos. A Vesuvius or an Etna, or a Cotopaxi in full blast, might supply in a day as much carbon dioxide as all the coal fires on earth can supply in a year.

So far we have been considering the problem on a world-wide scale. Suppose, now, that we put it upon a narrower, and what may be regarded as an approach to a more practical basis. Instead of trying to turn the whole atmosphere into a more effective hothouse cover for the earth than it now is, might we not conserve heat energy, of whatever origin, in reservoirs of limited extent, from which it could be released when and where wanted, as, for instance, inside houses, shops, stores, factories, etc., letting the outside air take care of itself, as we are forced to do at present?

Imagine attached to every dwelling house and every other inhabited structure a chamber, or an annex, to contain heat, just as we have iceboxes and cold air apartments to contain "stored cold." This is the thermos bottle idea. The conservation of heat is easy enough, although to keep it for months would require improvements in the structure of the non-conducting walls—but such improvement could unquestionably be effected. The great difficulty would be to obtain the heat at a sufficiently high temperature and in sufficient quality, and to concentrate it in manageable forms.

Heat is due to molecular agitation, or vibration. If the vibration is communicated to other bodies, or substances, their temperature is raised at the expense of the heated body, which becomes colder, until it has sunk to the general level of the surrounding temperature. Now, we get a heat-storage hint from what happens in the Fall of the year. The soil, during the hot days of July and August, becomes penetrated to a considerable depth by the heat vibrations, originally derived from the sun, and this heat is temporarily stored in the ground, but the storage is imperfect, something like putting water in a pail whose bottom is perforated with pinholes. During September, October and even part of November, the stored up heat gradually escapes, and being diffused through the air postpones the arrival of the first frosts of Winter.

Suppose some way could be devised to control the leakage of Summer heat from the ground, so that the amount stored in ten acres would be diverted to the interior of a chamber 40x40 feet in basal area, and delivered to the living apartments by a system of pipes of non-conducting material, such as asbestos. This supposes the air of the distributing chamber to be first warmed by the heat from the ground, and if that heat represented the radiation from ten acres of surface, of course some way would have to be found to conduct it to the chamber without sensible loss. I have no data showing how many heat units may be stored in an acre of ground during the hottest part of the Summer, but the amount must be large.

There are many other conceivable ways in which, if only the necessary apparatus can be constructed, not only solar heat, but even heat derived from artificial sources, could be stored in hot seasons for use in cold ones. Whether these would be "commercially successful" is another question, but when faced with extreme suffering or death men care nothing about the commercial aspects of what they do. Water is a great storer and conveyor of heat, as witness our house furnaces, and on nature's scale, the Gulf Stream.

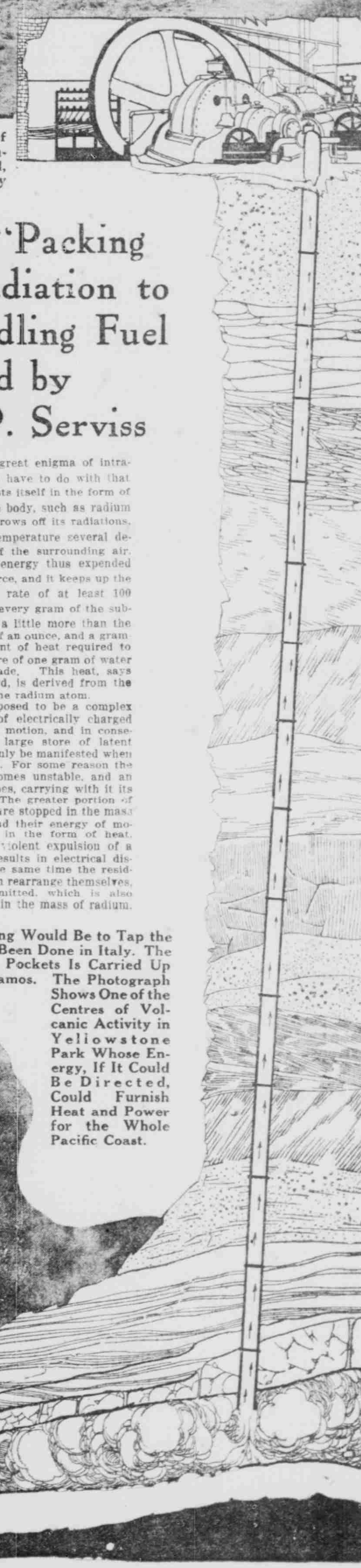
A variant on this class of suggestions is one once put forth by the French astronomer, Camille Flammarion, for digging heat, as it were, out of the depths of the earth. It is known that, owing to the increasing pressure, the temperature of the earth's crust increases on an average one degree for every 50 to 100 feet of descent. Put the average at one degree to 75 feet, and we see that at a depth of ten miles the temperature should be about 700 degrees, or more than three times that of boiling water; and at twenty miles 1,400 degrees, and so on. The quantity of heat in the earth's interior is almost incalculable. Besides, much of it does not lie at such great depths, for in volcanic regions molten rock often actually emerges on the surface. M. Flammarion's idea was to reach this great store of heat by digging a great shaft, or a series of shafts, say ten or twenty miles deep—a job for engineers of the Jules Verne of the Martian pattern! Water heated by the earth's internal heat could then be piped to the surface and turned into the hot-water pipes now used in our houses.

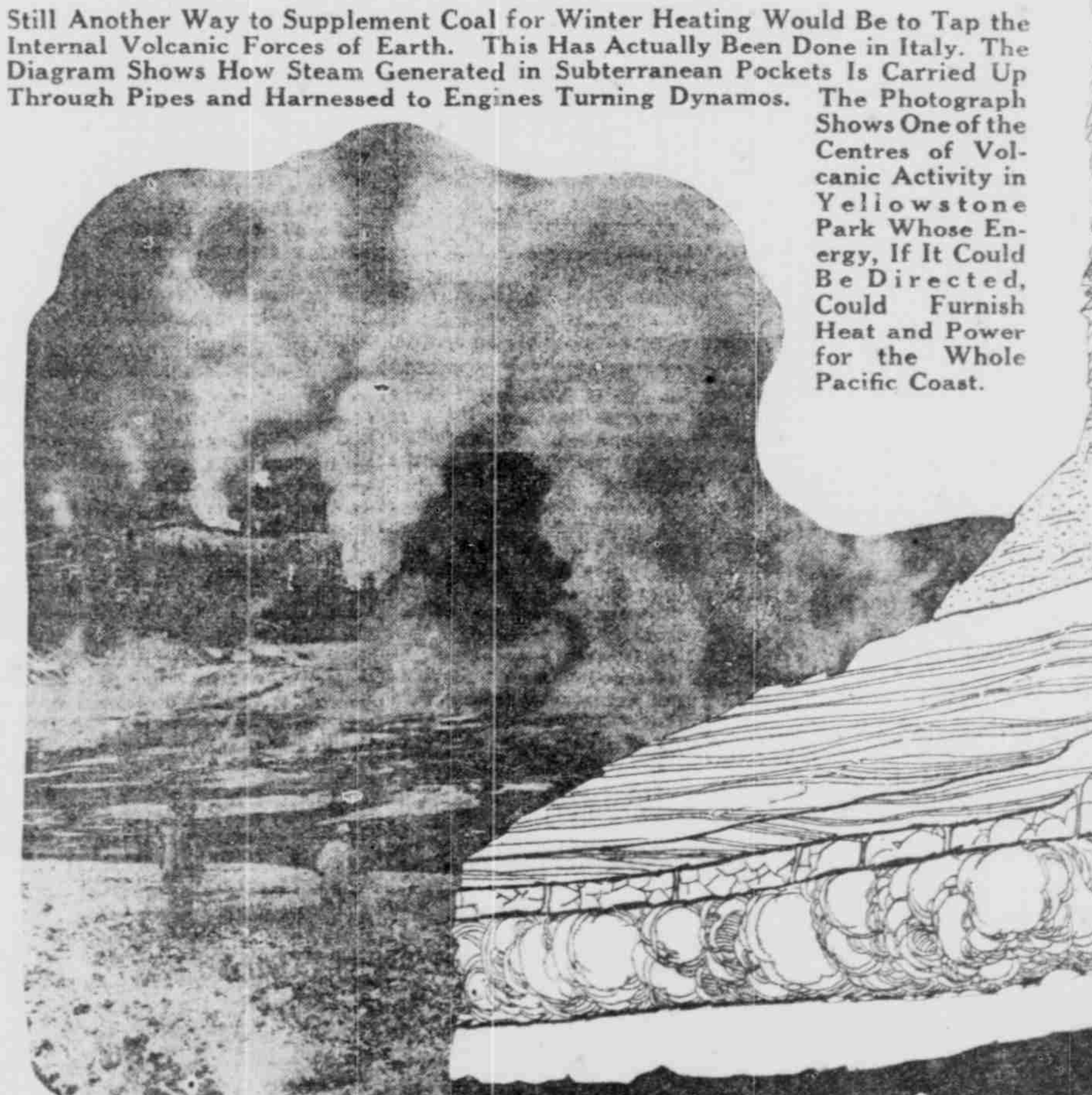
In Central Italy there are a large number of small volcanic vents called "fumaroles." The steam from these has been used to charge dynamos, which now supply electric power for lighting and traction purposes over two square miles.

But now, taking up the second line of solution for the problem before suggested, we come to a truly revolutionary idea, which may turn out to be a sign-post of the predestined way that civilization is to tread toward its final summit of achievement.

We confront the great enigma of intra-atomic energy. We have to do with that energy as it manifests itself in the form of heat. A radioactive body, such as radium bromide, while it throws off its radiations, keeps itself at a temperature several degrees above that of the surrounding air. It draws the heat energy thus expended from no outside source, and it keeps up the expenditure at the rate of at least 100 gram-calories from every gram of the substance. A gram is a little more than the twenty-eighth part of an ounce, and a gram-calorie is the amount of heat required to raise the temperature of one gram of water one degree centigrade. This heat, says Professor Rutherford, is derived from the internal energy of the radium atom.

The atom is supposed to be a complex system consisting of electrically charged parts in very rapid motion, and in consequence contains a large store of latent energy, which can only be manifested when the atom breaks up. For some reason the atomic system becomes unstable, and an alpha particle escapes, carrying with it its energy of motion. The greater portion of the alpha particles are stopped in the mass of radium itself, and their energy of motion is manifested in the form of heat. Then, because the violent expulsion of a part of the atom results in electrical disturbance, and at the same time the residual parts of the atom rearrange themselves, more energy is emitted, which is also manifested as heat in the mass of radium.





Still Another Way to Supplement Coal for Winter Heating Would Be to Tap the Internal Volcanic Forces of Earth. This Has Actually Been Done in Italy. The Diagram Shows How Steam Generated in Subterranean Pockets Is Carried Up Through Pipes and Harnessed to Engines Turning Dynamos. The Photograph Shows One of the Centres of Volcanic Activity in Yellowstone Park Whose Energy, If It Could Be Directed, Could Furnish Heat and Power for the Whole Pacific Coast.